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Spatial and seasonal variation in polychaete communities according to their trophic categories in Southwest Tobago, West Indies

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ABSTRACT

Bon Accord Lagoon (BAL), Tobago is home to a *Thalassia testudinum* (K.D. Koenig, 1805) dominated seagrass community and polychaetes usually show an affinity to seagrass beds compared to other environments. The objectives of this study were to investigate the polychaete community associated with the *Thalassia* beds in BAL, determine seasonal variation, and compare with the neighbouring hard bottom polychaete community in Mt. Irvine Bay (MIB). Benthic macroinvertebrates were sampled using a 15 cm diameter corer at a depth of 10 cm. Six stations were sampled during the wet and dry seasons of 2018. Samples were sieved in the field using a 0. 5 mm mesh screen. They were stained and preserved with a 10% formalin-seawater mixture, sorted and macrofaunal species identified to the lowest possible taxonomic level. Thirty – one polychaete families were ranked according to trophic categories as described by Fauchald and Jumars (1979) and updated where possible. Average family density for the dry season was recorded at 206.89 ± 307.53 ind/m^2 and 129.55 ± 227.23 ind/m^2 for the wet. Maldanidae and Syllidae recorded highest densities for dry and wet seasons respectively. Deposit feeders were the largest trophic group represented across both seasons in the BAL with Maldanidae being the most dominant. Carnivorous polychaetes dominated MIB with Syllidae being the most dominant. BAL showed higher diversity and richness compared to MIB. Based on functional traits of the community the environment at BAL can be regarded as healthy. This study establishes a much-needed baseline for future research and management of marine biodiversity in southwest Tobago.

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Introduction

Seagrass systems are generally associated with increased richness of benthic communities in terms of species and individuals [1,2]. The structural complexity created by the seagrass canopy provides refuge and breeding grounds for numerous invertebrates and fishes [3–7] leading to increased species abundance and diversity compared to areas without seagrass vegetation [4,5,8,9]. Shoot density, leaf surface and biomass influence the composition and abundance of fauna associated with seagrass beds [10,11]. Polychaetes in particular thrive in seagrass beds [12] such as the *Thalassia testudinum* (K.D. Koenig, 1805) dominated seagrass community found in Bon Accord Lagoon (BAL), Tobago and often have the highest species richness and abundance of all invertebrates found in seagrass beds [4,12–15].

While there are thriving seagrass beds in BAL, the majority of Tobago's coastline is comprised of coral and rocky ecosystems which provide different habitats suitable for other polychaete taxa. Previous work has shown that the polychaete family Syllidae is highly successful in inhabiting hard bottom substrate habitats [16], making their dominance in Tobago expected [17].

In a review of the literature on polychaetes of the Caribbean Sea, Trinidad and Tobago was listed as one of the more species rich polychaete environments [17]. The most species rich family was Syllidae with 159 recorded species followed by Eunicidae (98), Nereididae (73), Polynoidae (66), Sabellidae (64), Serpulidae (64), Terebellidae (62), and Spionidae (56). Dean (2012) [17] identified 1,205 species for the Caribbean Sea which is more than double the 546 described by Gobin in Miloslavich et al., (2010) [18]. This suggests that there is still plenty to learn about the regional fauna, and highlights the importance of these organisms to regional marine biodiversity.

Most of the polychaete studies conducted in Trinidad and Tobago have been off the west coast of Trinidad, and in close proximity to the Point Lisas Industrial Estate [19]. Gobin (1990) [20] created a polychaete checklist from a number of soft-bottom sediment benthic surveys carried out primarily on the west coast of Trinidad. Agard (1984) [21] and Agard *et al*. (1993) [22] described the soft-bottom macrobenthic intertidal communities on the northwest and southwest peninsulas of Trinidad. Kanhai & Juman (2018) [23] investigated benthic communities within the Caroni Swamp. This study indicated that anthropogenic pollutants

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influenced the polychaete communities at various sites. Another recent study described the polychaete population on Trinidad's southeastern tip at the Port of Galeota [24] which found the benthic communities to be relatively unaffected by human activities.

Few attempts have been made to describe the polychaete populations in Tobago. An unpublished study entitled "An Investigation of the Benthic Macrofauna of *Thalassia* beds of Trinidad and Tobago" by Daniel in 2010 found 130 different benthic macrofaunal species with 20 polychaete families accounting for 42% of all species represented in BAL. Gobin (2010) [25] described the hard bottom polychaetes found at MIB, Tobago as part of a wider national study.

In addition to the insights polychaetes can provide on community distribution patterns [26], trophic structure analysis is also useful in assessment of the distribution of benthic communities and as a tool for ecological and environmental benthic studies [27]. Taxonomic studies may not always highlight all relevant information that can be uncovered by taxonomic groupings [28–30]. Multiple feeding modes of polychaetes enables them to provide information on trophic structure of macrobenthic communities [31].

To establish a much-needed baseline for future research and management interventions in BAL given that the seagrass beds are being progressively disturbed by coastal development and other human activities [32–35] we undertook to survey the characterised the polychaete communities of Tobago and highlight their trophic groups. This work also adds new information to the polychaete records of species found in Trinidad and Tobago. The objectives of this study were: (i) Assess the polychaete community in Southwest Tobago and group them into trophic categories (ii) Compare the polychaete community across wet and dry seasons in BAL (iii) Compare the polychaete communities between a seagrass dominated site and a hard bottom unvegetated site (iv) Establish the status of the environment in BAL based on the functional traits of the polychaete community and (v) Establish a baseline for future environmental assessment of the benthic environment in southwest Tobago.

Methodology

Site Description

Trinidad and Tobago (T&T) is located on the continental shelf of South America, and immediately adjacent to the outflow of the Orinoco River. The country is less exposed to tropical storms and hurricanes than most of the Caribbean nations because of its southerly location, and has a tropical climate with two distinct seasons [36]. The dry season occurs between January and April, while the wet season extends from June to November. May and December are considered transitional months between the two seasons. Its marine ecosystems are influenced by discharge from South American Rivers, mainly the Orinoco River, while its terrestrial biota is largely South American.

Bon Accord Lagoon (BAL)

BAL lies in the southwestern region of Tobago at latitude 11°10′and 11°11′N and longitude, 60°49′ and 60° 51′ E (Figure 1).

The seagrass community in BAL covers an area of approximately 102 ha.[2] and extends in some places to a depth of approximately 6 m [37]. The seagrass beds are found in three main areas: north of Sheebird's Point in the back reef area, south of Sheebird's Point and in the Lagoon extending from east of Gibson's jetty straight toward the southeastern end Pigeon Point [37]. Turtle grass, *T. testudinum* is the dominant seagrass species in the Lagoon while smaller areas of *Halophila decipiens* (Ostenfeld, 1902) and *Halodule wrightii* (Ascherson, 1868) are interspersed among the turtle grass [37]. The dominant algal genera are *Acanthophera, Padina, Bryopsis, Dictyota, Halimeda* and *Caulerpa* while corals such as *Porites porites* (Pallas, 1766) also occur in the lagoon among the seagrass beds [37]. Grain size analysis performed at sampled stations by Daniel (2010, unpublished) showed the substrate to be comprised of gravelly sand (GS) with a sand range of 85.06–94.90 %; gravel range of 5.00–13.75 % and a mud range of 0.1–2.31 %. Salinity averaged 36.20‰ for the dry season and decreased to 29.02‰ for the wet. Temperature averaged 27.10 °C for the dry season and increased to 29.02 °C for the wet. Dissolved oxygen averaged 6.87 mg/l for the dry season, and 5.84 mg/l for the wet. pH averaged 7.77 for the dry season and 7.95 for the wet.

Mt. Irvine Bay (MIB)

MIB is located at 60°79′ E 11°18′N in the southwestern region of Tobago (Figure 1).

The bay consists of two sections separated by an outcrop of coral-algal limestone with one section extending east-west and the other north-south. The east-west section of the bay is 550 m long with a sea wall protecting the road. Rough seas are experienced between November and April at this section of the bay. Waves of moderate energy approach from the northwest with 30 cm average height for the dry season and 16 cm for the wet season. Weak longshore currents flow to the southwest at an average speed of 6 cm/s.

The sediment is comprised of light-brown, medium-grained sand composed mainly of quartz. The north-south section of the beach is 600 m long and usually calmer for sea bathing [38]. There were no available environmental parameters for MIB.

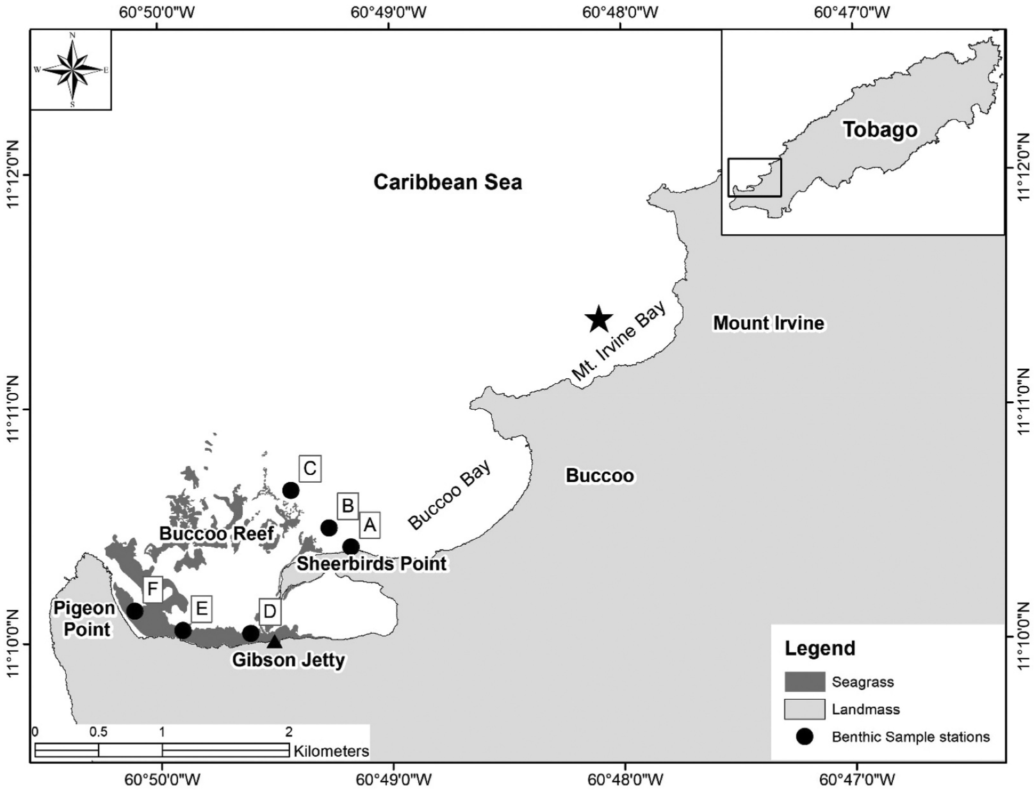

Figure 1. The location of seagrass sample sites in Bon Accord Lagoon (BAL) with sampling stations labelled A-F and the hard bottom sample site taken from Gobin [25] in Mt. Irvine Bay (MIB).

Sampling Methods

Field Sampling

Benthic macrofauna were collected among seagrass beds within the BAL during two sampling periods, dry and wet season 2018 (March and September, respectively) using a hand held PVC corer. The National Geography in Shore Areas (NaGISA) protocol [39] for sampling seagrass infauna was used which involved immersing a 15 cm diameter corer to a depth of 10 cm and using a rubber bung at the top of the device to create a vacuum.

A pre-sampling experiment was conducted to determine the number of replicates required to accurately determine benthic composition per site. The cumulative frequency curve suggested five replicates would be adequate (Figure 2).

Core samples were sieved in the field using a 0.5 mm mesh screen. Samples were stained with Rose Bengal and preserved with a 10% formalin-seawater mixture. The benthic organisms studied were polychaetes, which were sorted and identified to the lowest possible taxonomic level using the

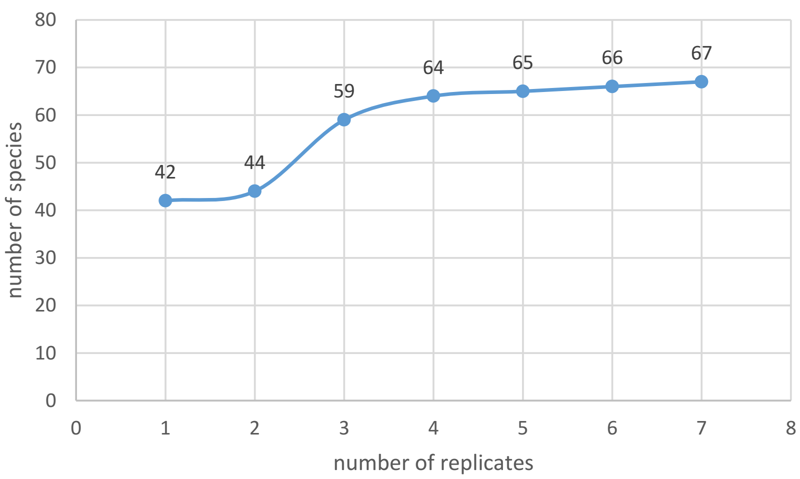

Figure 2. Cumulative frequency curve for pre-sampling experiment conducted at William's Bay.

key: The Polychaete worms [40]. Accepted taxa were checked at World Register of Marine Species www.marinespecies.org [41].

Seagrass shoots were sampled using the CARICOMP Methodology [42]. At each seagrass location, six 10 × 20 cm (0.2 m^2) PVC quadrats were randomly deployed. All the seagrass shoots in each of the quadrats were counted.

Analysis of results

Species constancy and the Biological Dominance Index were calculated based on McCloskey (1970) [43]. Shannon's species diversity H'Σ– = i2iplogp, and evenness E = H'/log2S [44] were calculated using PRIMER 6 along with Analysis of Similarity (ANOSIM) and cluster analysis [45]. These indices are commonly used when conducting benthic population studies. To achieve homogeneity of variances, densities were transformed to log10 (n + 1). One-way ANOVA [46] and Paired-t tests [47] were performed to ascertain differences between the seasons sampled.

Comparison with Gobin (2010)

The macrobenthic population at MIB, Tobago recorded in Gobin (2010) [25] was compared with the soft bottom benthic seagrass communities in the present study. These hard bottom communities were sampled using five Artificial Substrate Units (ASUs) (Figure 3) as part of a wider study of hard bottom benthic communities throughout varying sites in Trinidad and Tobago.

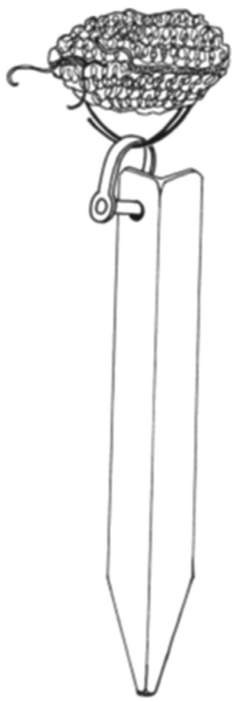

Figure 3. Artificial Substrate unit used by Gobin (2010) to investigate the hardbottom communities of MIB.

The area sampled by the ASUs was not given. This meant it was not possible to calculate abundance per square metre for comparisons with the present study. Trophic categories of the polychaetes sampled in MIB and BAL were established using the framework provided by Fauchald & Jumars [48], and later updated by Jumars et al. [49]

Results

Seasonal comparison

Polychaete families, abundance per square metre, biological index of dominance, trophic categories and constancy of occurrence in BAL are presented in Table 1. The full species table is presented in Appendix A1.

One thousand and twelve (1,012) individuals (56,226 ind/m^2) belonging to 30 families and 68 species (51 to the generic level and 17 to the specific level), were collected across both seasons in BAL. Six hundred and sixty-five (665) individuals were found during the dry season and 347 found during the wet season. Average family density for the dry season was recorded at 206.89 ± 307.53 ind/m^2. This decreased during the wet season to 129.55 ± 227.23 ind/m^2. Maldanidae recorded the highest density during the

Table 1. Polychaete families collected in Bon Accord Lagoon, (Total BAL) Tobago, Trophic Category (TC), (D) density average (ind/m^2), Standard Deviation (SD), Biological Index of Dominance (Bid), DF: Deposit Feeder, C: Carnivore, FF: filter feeder, O: Omnivore and family counts collected at Mt.Irvine Bay (MIB) *For full species table please see Appendix* 1.

Family	Total BAL	D ind/ m2	S.D.	T. C.	BID dry	BID wet	BID total	MIB
Ampharetidae	2	56	0.00	DF	93	95	188	9
Aphroditidae								16
Capitellidae	88	2464	39.60	DF	582	381	963	0
Cirratulidae	54	1512	1.41	DF	565	377	942	0
Cossuridae	4	112	2.83	DF	178	0	178	0
Dorvilleidae	86	2408	2.83	O	474	483	957	0
Eunicidae	15	420	9.19	DF	371	94	465	2
Flabelligeridae	8	224	5.66	DF	183	0	183	0
Glyceridae	6	168	0.00	C	277	185	462	0
Hesionidae	2	56	1.41	C	0	92	92	5
Lumbrineridae	24	672	1.41	O	463	466	929	0
Magelonidae	9	252	2.12	DF	179	96	275	0
Maldanidae	218	6104	33.94	DF	494	493	987	0
Nephtyidae	1	28	0.71	O	85	0	85	0
Nereididae	99	2772	33.23	C	484	387	871	1
Oenonidae	1	28	0.71	DF	84	0	84	1
Onuphidae	7	196	3.54	C	191	90	281	0
Opheliidae	57	1596	9.19	DF	369	478	847	0
Orbiniidae	11	308	7.78	DF	363	0	363	0
Paraonidae	79	2212	33.23	DF	292	474	766	0
Pectinariidae	2	56	1.41	DF	88	0	88	0
Phyllodocidae	1	28	0.71	C	0	91	91	4
Pilargidae	4	112	2.83	O	174	0	174	0
Polynoidae	7	196	3.54	C	354	88	442	14
Sabellidae	60	1680	33.94	DF	561	280	841	29
Serpulidae	5	140	3.54	FF	0	97	97	94
Sigalionidae	1	28	0.71	C	0	90	90	0
Spionidae	9	252	6.36	DF	360	0	360	0
Sternaspidae	1	28	0.71	DF	83	0	83	0
Syllidae	145	4060	16.26	C	480	373	853	216
Terebellidae	6	168	2.83	DF	88	274	362	10

dry season (1241.33 ± 20.72 ind/m^2) while Syllidae recorded the highest density during the wet season (683.20 ± 23.97 ind/m^2).

Deposit feeders were the largest trophic group represented across both seasons with 422 and 195 individuals recorded for dry and wet seasons, respectively (Table 2).

This was followed by carnivores (172 dry; 95 wet), omnivores (67 dry; 52 wet) and filter feeders (4, dry; 5, wet). Highest abundance was recorded at Station F for the dry season while B had the lowest. Wet season abundance was highest at Station A and lowest at F (Table 3).

The paired t-test comparing polychaete populations in the wet and dry seasons gave a P-value of greater than 0.05 failing to reject the null hypothesis, and finding no significant difference between the seasons (Paired T-test, $P > 0.05$). (See Table 2 Appendix for values).

Species richness was highest at Station F and lowest at Station B for the dry season whereas during the wet season, B was highest and F was lowest (Table 3). There was a significant difference between the seasons (Paired T-test, $P > 0.05$).

Species diversity was highest at Station F and lowest at Station B for the dry season. Station B was highest and F was lowest for the wet season (Table 3). Species diversity showed significant difference between seasons (Paired T-test, $P > 0.05$).

For the dry season evenness was highest at Station C and lowest at Station E. Station C recorded the highest value for the wet season again while F recorded the lowest (Table 3). There was a significant difference between the seasons for evenness (Paired T-test, $P > 0.05$).

The highest number of deposit feeders were recorded at Station F for the dry season and this fell to 0 during the wet season (Figure 4). Station F is located on the eastern side of the lagoon near Pigeon Point, a sandy beach.

The largest number of omnivores (31) and carnivores (57) were recorded at station A during the wet season. Station B recorded the most filter feeders during the wet season (5). Station A and B are located north of Sheerbird's Point in the back reef area.

Thalassia shoot density ranged from 270 to 340 shoots/m^2 for the dry season and 325 to 400 shoots/m^2 for the wet season. A significant positive Pearson Correlation was found between the number of *Thalassia* shoots and Shannon's diversity index for polychaetes ($r = 0.13$, $P < 0.01$) (See Table Appendix 2 for values). *Thalassia* shoot density and species richness also showed a positive Pearson Correlation ($r = 0.43$, $P < 0.01$); species richness and Shannon's diversity ($r = 0.82$, $P < 0.05$) were also positively correlated across both seasons. During the dry season, Station E recorded the highest shoot density with a value of 408 shoots/m^2, followed by station D (340) and Station C (270). For the wet season station D recorded the highest shoot density with a value of 400 shoots/m^2, followed by Station E (341) and Station C (325).

Cluster analysis produced three groups (Figure 5). Stations A, B and C for the dry season produced one group with low similarity levels and the remaining stations D, E and F producing another group with similarity of greater than 50%. All the wet season stations with the exception of F, which was excluded, produced one group with similarity levels of less than 50%.

Table 2. Number of polychaete individuals belonging to different trophic categories found in stations A – F. (DF) deposit feeders, (O) omnivores, (C) carnivores, (FF) filter feeders.

	DF		O		C		FF	
	dry	wet	dry	wet	dry	wet	dry	wet
A	51	27	22	31	44	57	1	0
B	27	40	2	2	2	11	0	5
C	16	23	12	5	12	5	0	0
D	52	30	3	8	47	8	2	0
E	107	75	13	6	19	14	1	0
F	169	0	15	0	48	0	0	0
TOTAL	*422*	*195*	*67*	*52*	*172*	*95*	*4*	*5*

Table 3. Species Abundance, Richness, Evenness and Shannon's Diversity for sampled stations across the wet and dry seasons in Bon Accord Lagoon.

	Abundance		Richness		Evenness		Shannon's Diversity	
Sample	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
A	118	115	21	15	0.87	0.71	2.60	1.93
B	31	58	13	21	0.85	0.87	2.18	2.66
C	40	33	14	11	0.90	0.89	2.37	2.13
D	104	46	24	14	0.83	0.82	2.60	2.15
E	140	95	25	18	0.82	0.73	2.60	2.10
F	232	0	28	0	0.84	0	2.77	0

Polychaete species composition in BAL and MIB

The polychaete community in BAL was more diverse than the community in MIB. In BAL, 68 species from 30 families were recorded while at MIB, the hard bottom polychaete population comprised 39 species from 12 families (Table 1). The Shannon's diversity index was 2.53 for the soft bottom seagrass community and 1.44 for the hard bottom polychaete community. Species evenness for the hard bottom community was calculated as 0.58 whereas for the seagrass community it was 0.74. The seagrass population sampled with the corer comprised 1,012 individuals whereas the ASUs counted 401 individual polychaetes in the hard bottom substrate (Table 1). Fifteen species were found in common at both sites.

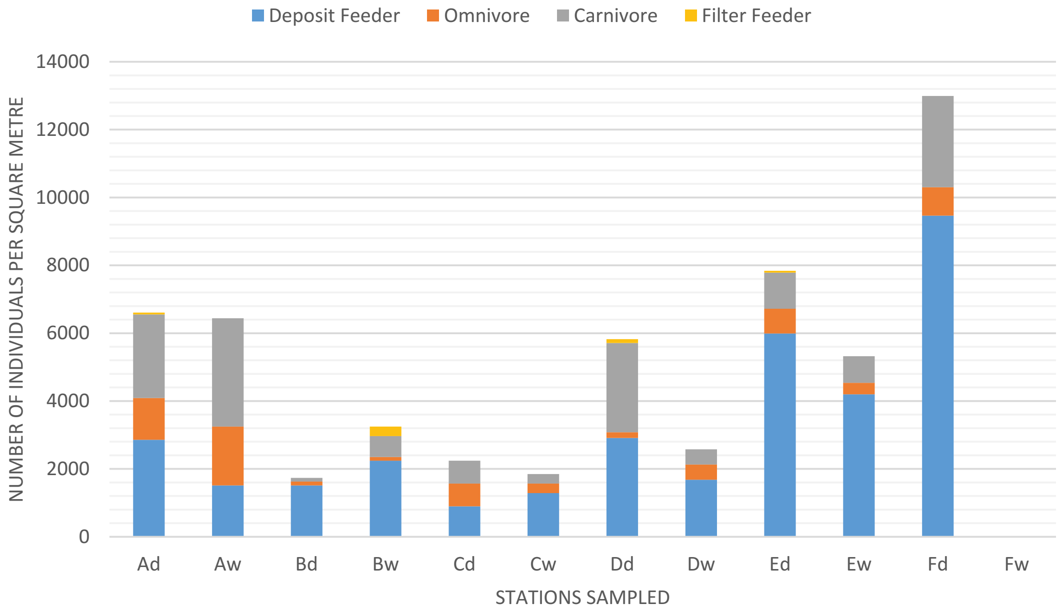

Figure 4. Polychaete individuals belonging to different trophic categories found in stations A – F where "d" denotes dry season and "w" denotes wet season.

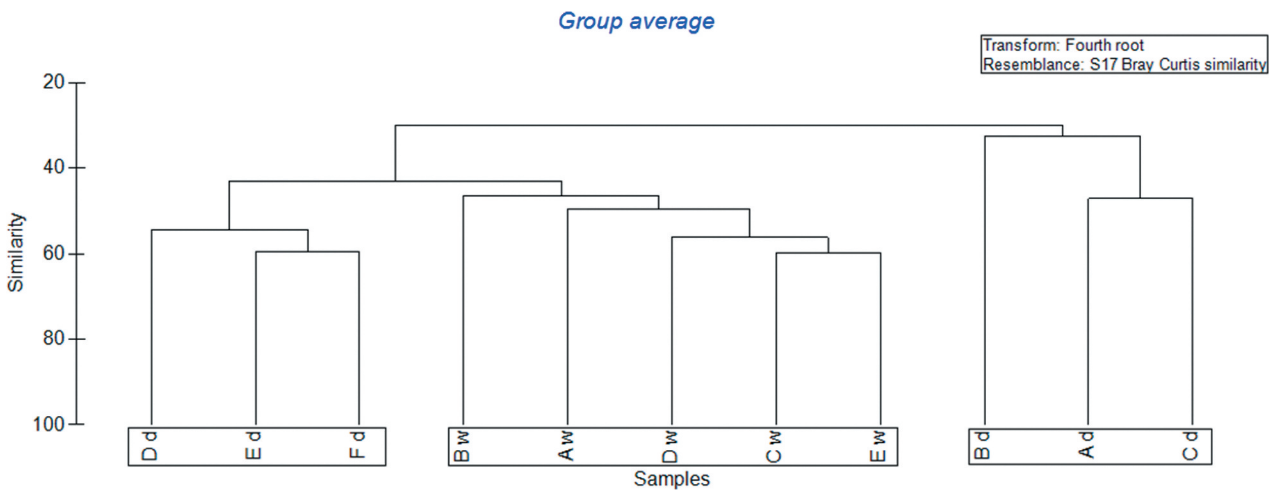

Figure 5. Dendrogram of stations sampled in Bon Accord Lagoon for wet and dry seasons. Upper case letters refer to the location of the sampling station described in Figure 1. Lower case letters refer to the season sampled, where "d" denotes the dry season and "w" denotes the wet season.

Syllidae was the most dominant family in the hard bottom population with 216 individuals, accounting for 55% of all species found. This was followed by Serpulidae (94 individuals, 24%), and Sabellidae (29 individuals, 8%). The most dominant family in the seagrass bed was the Maldanidae with 218 individuals, accounting for 22% of the population followed by Syllidae (145 individuals, 14%) and Nereididae (99 individuals, 10%).

Trophic categories

For the seagrass beds, deposit feeders were the most represented trophic group accounting for 61% of all individuals recorded (616 individuals) (Figure 6) This was followed by carnivores at 26% (268 individuals), omnivores at 12% (119 individuals) and filter feeders at 1% (9 individuals) (Figure 6). For the hard bottom communities, carnivores were the most represented trophic group accounting for 61% (246 individuals) and dominated by the Syllidae family followed by deposit feeders with 28% (47 individuals) and herbivores at 8% (14 individuals) (Figure 6).

Of the five most abundant species at the hard bottom site, three were carnivores: *Pinosyllis sp.1, Pontogenia sp.1 and Syllis sp1*., one was a filter feeder *Pseudovermilia occidentalis* (McIntosh, 1885) and one was a deposit feeder *Paradialychone americana* (Day,

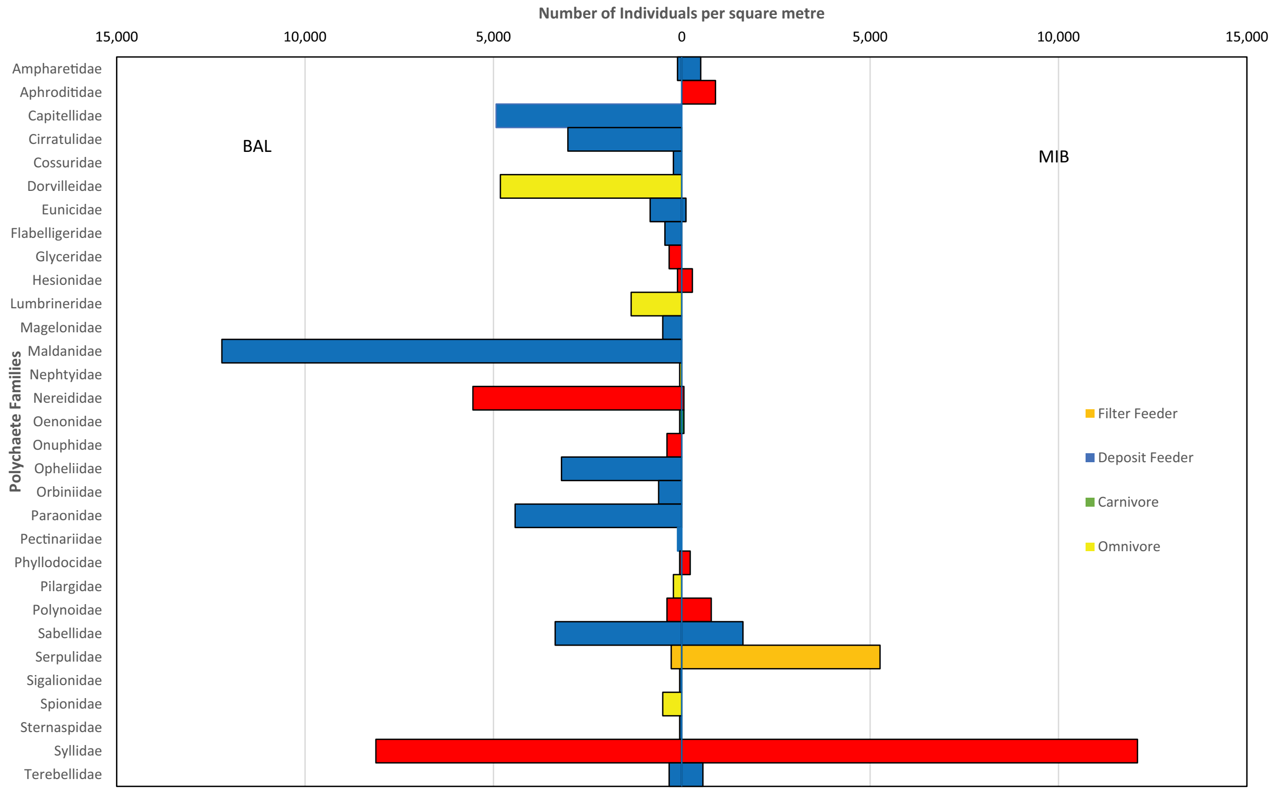

Figure 6. Number of polychaete individuals and their trophic categories found in Bon Accord Lagoon (BAL) and Mt. Irvine Bay (MIB).

1973). Of the five most abundant species at the seagrass site, two were deposit feeders: *Maldane sp*, and *Capitella capitata* (Fabricius, 1780) two were carnivores *Syllis sp.1* and Nereididae sp1, and one was an omnivore, *Dorvillea sp.1*.

Fifteen species from 10 families were common to both sites: Ampharete sp 1., *Eunice websteri* Fauchald, 1969, Nereididae sp1, *Arabella iricolor* (Montagu, 1804), *Mystides borealis* Théel, 1879, *Harmothoe sp1., Lepidonotus sublevis* Verrill, 1873, *Bispira melanostigma* (Schmarda, 1861), *Sabella sp1., Sabella sp2., P. occidentalis, Syllis prolifera* Krohn, 1852, *Syllis Sp1, Trypanosyllis sp 1* and Terebellidae Sp 1. (8 Carnivores, 6 Deposit feeders and 1 Filter feeder).

A two-tailed t-test conducted between the families at both sites failed to reject the null hypothesis, indicating that there is no difference between families at both sites ($P > 0.05$). ANOSIM conducted for substrate type also confirmed this finding ($P = 0.1$, $R = 0.46$).

Community analysis was performed for the polychaete families found at both sites. A description of the functional traits and whether these families are indicators of pollution can be seen in Table 4.

Discussion

Of the five most abundant polychaete species in the dry season in BAL, two were deposit feeders (*C. capitata* and *Maldane sp.1*.), one was a carnivore (*Syllis sp.1*) and two were omnivores (*Dorvillea sp.1* and *Lumbrineris sp.1*). This is similar to a study conducted in the Gulf of Mexico which reported Capitellidae and Maldanidae among the dominant polychaete families, and the majority of polychaete families being either suspension or deposit feeders from soft-bottom seagrass communities [56]. Capitellidae can be used as indicators of organic enrichment [57] along with the presence of Nereididae [57]. Capitellidae also impact the biogeochemistry by burrowing and ingesting of sediments which influence particle distribution [58]. The absence of Maldanidae on the other hand is normally an indicator of poor environmental quality [59] ie. Their presence indicates good environmental quality.

The wet season showed dominance by deposit feeders with four deposit feeders (*Maldane sp.1, Armandia sp.1, Euclymene sp.1* and *Aricidea sp.1*) being the most abundant, with only one omnivore (*Dorvillea sp.1* (Appendix A1).

Trophic structure of polychaete communities in the Caribbean do not show much variation from one season to the next. Studies conducted in Colombia at a higher frequency than the present study (3 to 4 times per year) [60,61] showed no significant changes between the dry and wet periods indicating no seasonal variability. The results of this study are consistent with other studies conducted in tropical soft-bottom

Table 4. Functional traits and pollution characteristics of the polychaete families found at BAL and MIB.

Family	Functional Traits/ Pollution Characteristics	Reference
Maldanidae	absence is an indicator of poor conditions, i.e. their presence is an indicator of good quality	Dean 2008 [59]
Syllidae	decrease with increasing organic material	Dean 2008 [59]
Nereididae	polluted zone found in conjunction with *Capitella*	Pearson and Rosengberg 1987 [57]
Capitellidae	Indicator of organic enrichment	Pearson and Rosenberg 1987 [57]
Dorvilleidae	The genus *Dorvillea* are less pollution tolerant	Dean 2008 [59]
Paraonidae	found in non polluted mangroves	Dean 2008 [59]
Sabellidae	indicators of non-pollution	Dean 2008 [59]
Ophellidae	*Armandia* live in uncompacted surface sediments, undulatory burrowers, found in high intertidal, sandy beaches	(Law, Dorgan, & Rouse, 2014) [50]
Cirratulidae	Presence of *Chaetozones setosa* indicate stressed communities	Dean 2008 [59]
Lumbrineridae	characteristic of semi healthy bottom when present with *Polydora, Neanthes, Dorvillea*; absence is an indicator of poor conditions, i.e. their presence is an indicator of good quality	Pearson and Rosengberg 1987 [57]; Dean 2008 [59]
Eunicidae	found among *Thalassia* beds	Diaz-Castaneda and Reish 2009 [58]
Orbiniidae	pollution indicator	Dean 2008 [59]
Magelonidae	found in non-polluted mangroves	Dean 2008 [59]
Spionidae	weakly associated with pollution, *Streblospio* influenced by pollution; *Aricidea* found in non polluted mangroves	Pearson and Rosenberg 1987 [57]; Dean 2008 [59]
Flabelligeridae	Found in diverse habitats, hard and soft bottoms.	(Oug, E; Bakken, T; Kongsrud, 2011) [51]
Onuphidae	refuge forming in shallow water, medium grained flats, positively correlated with abundance and species richness of associated infauna; negatively affected by industrial and sewage pollution	Diaz-Castenada and Reish 2009 [58]; Dean 2008 [59]
Polynoidae	absence of *Harmothoe* indicates low diversity due to detrimental environmental conditions	Dean 2008 [59]
Glyceridae	consume nereids which allows other genus such as: *Polydora, Streblospio, Scoloplos* to fluorish; *Glycera* correlated to high diversity	Diaz-Castaneda and Reish 2009 [58]; Dean 2008 [59]
Terebellidae	good indicators of species richness; absence is an indicator of poor conditions, i.e. their presence is an indicator of good quality	Diaz-Castaneda and Reish 2009 [58]; Dean 2008 [59]
Serpulidae	can be an indicator of stressed conditions (hypoxia)	Dean 2008 [59]
Cossuridae	burrowers normally able to escape predation	Diaz-Castaneda and Reish 2009 [58]
Pilargidae	usually free-living, surface sediment dwellers	Dept of Agriculture, Water and the Environment, Australia [51]
Ampharetidae	Their fragile tubes are constructed of mud or sand grains and attached to sponges, compound ascidians or the shells of living molluscs. Only a few of them live in shallow water but they are common in deep water	Day, 1967 [52]
Hesionidae	Hesionids are active carnivorous worms, found in crevices and amongst the plant and animal growths on hard substrata, with some species occur commensally on echinoderms and with other larger tube-dwelling worms.	annelida.net [53]
Pectinariidae	some genera are found associated with shoots of seagrass (*Zostera noltii*)	Diaz-Castaneda and Reish 2009 [58]
Nephtyidae	indifferent to pollution; insensitive to heavy metals	Pearson and Rosenberg 1987 [57]; Dean 2008 [59]
Oenonidae	Live in sand and mud as free-living burrowers, can be parasitic.	Zanol & Ruta, 2015 [53]
Phyllodocidae	found in depressions and slopes at moderate depths (44–75 m) on very fine sand.	Anderson et al. 2010 [54]
Sigalionidae	the genus *Pisione* normally prefer fine gravel to coarse sand with low organic material.	Martins *et al.* 2012 [55]
Sternaspidae	active burrowers, subsurface deposit feeders	Diaz-Castaneda and Reish 2009 [58]
Aphroditidae	Active carnivores	Dept of Agriculture, Water and the Environment, Australia [51]

and rocky shore communities, where neither number of taxa nor their abundances significantly changed during the year [62,63].

The hard bottom site at MIB was sampled using an entirely different methodology compared to BAL therefore focusing on abundance numbers could potentially be misleading. However, increased productivity, abundance and biodiversity between seagrass beds and unvegetated sites is well documented [5,64–69]. Seagrass beds support higher abundance and richness of faunal assemblages when compared to unvegetated sites [70]. It is therefore reasonable to suggest the polychaete assemblages at BAL are higher in abundance and diversity when compared to those found at MIB. The carnivorous polychaete family, Aphroditidae, was the only family not also found at the BAL study site. It is possible hard bottom seafloors would favour carnivorous polychaetes as prey are unable to burrow into seafloor to escape.

The significant correlation found between *Thalassia* shoot density and Shannon's Diversity and species richness supports the view that seagrass beds harbour a greater number and diversity of species due to increased shelter, food resources and protection from predation [10,11]. Two polychaete families in particular are found associated with seagrasses. The family Eunicidae are found among Thalassia beds [58] and the family Pectinariidae are found associated with the shoots of *Zostera* [58].

Gobin (2010) [25] stated that the hard bottom polychaete community was typical of hard bottom substrates found in New Zealand and the southwest coast of England [71]. The dominance, diversity and abundance of Syllidae among hard bottom, shallow water substrates is well-documented [72–75]. It has been suggested that Syllidae will generally dominate in any 3-dimensional environment where adequate microhabitats are present for settlement [76,77].

Syllidae will also be the first to colonise artificial substrate panels similar to those used by Gobin (2010) [25], however their long-term viability on those panels in terms of seasonal and environmental variation remains to be tested [78]. The composition of this population in general is in keeping with that found by Dean (2012) [17] for the Caribbean where Syllidae were the most dominant polychaete family along with a high number of Serpulidae. Syllidae are normally indicators of good environmental quality as their numbers tend to decrease with increasing organic material [59].

Given the high amount of coral reefs located around the coastlines of Tobago [79], the presence of large numbers of Serpulidae is unsurprising. Serpulidae can sometimes be regarded as indicators of stressed conditions, typically hypoxia [59]. In this case, the presence of Serpulidae appears to be more of a function of the substrate rather than water quality as there are numerous other polychaete families which serve as indicators of good environmental quality such as Sabellidae [59].

Sabellidae and Serpulidae comprised the main components of the filter-feeding group found at the hard bottom site in Tobago [25]. The hard bottom community showed marked differences with respect to trophic categories when compared to the soft bottom seagrass site with Syllidae (carnivore), Sabellidae (deposit feeder) and Serpulidae (filter feeder) being the most dominant families.

The range in the number of polychaete species recorded in *Thalassia* beds from the Atlantic American coast in previous studies is relatively wide, varying from 21 to 51 species, with an average of 35.71 ± 10.71; the range of densities is even wider, between 60 and 4,409 ind/m^2 (X = 1036.43 ± 1554.99) [80]. The number of species found at MIB (41) falls within this range. The number of polychaete species found at BAL- 68 is higher than this range but similar to communities sampled along the coastline in Rio de Janeiro Brazil [81] where 68 species were found among the *Halodule wrightii* (Ascherson, 1868) dominated seagrass beds. Species richness and average density values obtained in BAL are within the mean of the respective interval provided by Arana & Díaz (2006) [80].

Bell et al., (1993) [82] reported that polychaete seagrass populations studied in Tampa Bay, Florida were dominated by deposit-feeders. Omena & Creed (2004) [81] also reported *H. wrightii* seagrass beds in Rio de Janeiro Brazil were dominated by the deposit feeder *Magelona papillicornis* (Müller, 1858). Similar results were reported by Wan Shi et al., (2014) [83] in Johor, Malaysia where seagrass beds sampled were dominated by deposit-feeding polychaete families Spionidae and Capitellidae, as well as the carnivorous Glyceridae. Deposit- feeders were the most dominant trophic group accounting for 60% of all polychaetes followed by carnivores at 25% abundance in BAL.

Conclusion

This is the first study that describes the polychaete communities in BAL, Tobago. BAL was dominated by deposit-feeding polychaetes across both seasons while MIB was dominated by carnivorous polychaetes. The different in substrate type, namely, sandy vs hard bottom can explain this phenomenon as deposit feeders will be unable to feed in hard bottom conditions which would favour carnivorous polychaetes. Both sites can be characterised as being in good environmental standing as several polychaete families, characteristic of good environmental conditions are present. Both populations are typical of their characteristic substrate type. This study provides an important baseline, which can be used in the future to assess environmental quality and biodiversity changes in these areas.

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Table A1. Families, species and trophic categories (TC) of polychaetes discovered in Tobago at a hard bottom side and at a seagrass bed site. Carnivores (C), Deposit Feeders (DF), Filter Feeders (FF), Herbivores (H), Omnivores (O).

Family	Species	MIB (hard bottom site)	BAL (seagrass site)	TC
Ampharetidae	Ampharetic sp 1	9	1	C
	Amphicteis sp.1	0	1	DF
Aphroditidae	Pontogenia sp 1	16	0	C
Capitellidae	Capitella capitata	0	57	DF
	Dasybranchus sp.1	0	17	DF
	Mediomastus sp.	0	4	DF
	Notomastus filiformis	0	3	DF
	Notomastus latericeus	0	7	DF
Cirratulidae	Caulleriella sp. 1	0	20	DF
	Chaetozone sp.1	0	19	DF
	Cirratulus sp.1	0	1	FF
	Cirriformia sp.1	0	12	DF
	Cirriformia sp. 2	0	2	DF
Cossuridae	Cossura sp.1	0	4	DF
Dorvilleidae	Dorvillea sp.1	0	86	O
Eunicidae	Eunice websteri	1	15	DF
	Marphysa mortensi	1	0	DF
Flabelligeridae	Brada sp.1	0	8	DF
Glyceridae	Glycera sp.1	0	6	C
Hesionidae	Gyptis sp.1	0	2	C
	Hesionid genus a	4	0	DF
	Podarke sp 1	1	0	DF
Lumbrineridae	Lumbrineries sp.1	0	20	O
	Lumbrineris fragilis	0	1	O
	Lumbrineris latreilli	0	3	O
Magelonidae	Magelona sp. 1	0	8	DF
	Magelona sp. 2	0	1	DF
Maldanidae	Axiothella sp.1	0	1	DF
	Euclymene sp.1	0	55	DF
	Maldane sp.1	0	152	DF
	Maldane sp. 2	0	10	DF
Nephtyidae	Aglaophamus sp.1	0	1	O
Nereididae	Ceratonereis sp.1	0	12	C
	Nereid sp 1	1	57	C
	Nereis lamellosa	0	13	C
	Nereis sp. 1	0	6	C
	Nereis sp. 2	0	7	C
	Pseudonereis sp.1	0	4	C
Oenonidae	Arabella iricolor	1	1	DF
Onuphidae	Diopatra sp.1	0	1	DF
	Onuphis sp.1	0	6	C
Ophellidae	Armandia agilis	0	1	DF
	Armandia maculata	0	19	DF
	Armandia sp.1	0	36	DF
	Armandia sp. 2	0	1	DF
Orbiniidae	Leitoscoloplos sp.1	0	1	DF
	Leodamas sp.1	0	9	DF
	Scoloplos sp.1	0	1	DF
Paraonidae	Aricidea sp.1	0	36	DF
	Aricidea sp. 2	0	36	DF
	Aricidea sp. 3	0	6	DF
	Paradoneis sp.1	0	1	DF
Pectinariidae	Pectinaria sp.1	0	2	DF
Phyllodocidae	Eteone lacteal	1	0	C
	Mystides borealis	3	1	C
Pilargidae	Sigambra tentaculata	0	4	O
Polynoidae	Harmothoe sp 1	12	6	C
	Lepidonotus sublevis	2	1	C
Sabellidae	Branchiomma sp.1	0	3	FF

(*Continued*)

Table A1. (Continued).

Family	Species	MIB (hard bottom site)	BAL (seagrass site)	TC
	Chone americana	17	0	DF
	Jasmineira sp.1	0	1	DF
	Sabella melanostigma	10	1	DF
	Sabella sp 1	1	32	DF
	Sabella sp 2	1	3	DF
	Sabella fusca	0	20	DF
Serpulidae	Pseudovermilia occidentalis	94	5	FF
sigalionidae	Pisione sp.1	0	1	C
Spionidae	Polydora sp.1	0	4	O
	Prionospio sp.1	0	5	DF
Sternaspidae	Sternaspis scutata	0	1	DF
Syllidae	Amblyosyllis sp.1	2	0	C
	Eusyllis lamelligera	13	0	C
	Eusyllis sp. 1	9	0	C
	Exogone dispar	1	0	H
	Exogone lourei	8	0	H
	Haplosyllis spongicola	5	0	H
	Myrianida dentalia	10	0	C
	Myrianida sp 1	4	0	C
	myrianida sp 2	7	0	C
	myrianida sp 3	5	0	C
	Odontosyllis sp.1	5	0	C
	Opisthodonta sp. 1	4	0	C
	Pionosyllis sp. 1	80	0	C
	Pionosyllis wiesmanni	6	0	C
	Sphaerosyllis sp. 1	2	0	C
	Syllides sp. 1	13	0	C
	Syllis prolifera	15	11	C
	Syllis sp. 1	16	126	C
	Syllis sp. 2	4	0	C
	Trypanosyllis sp. 1	7	8	C
Terebellidae	Terebellid sp. 1	6	6	DF
	Terebellid sp. 2	4	0	DF
TOTAL		**401**	**1012**	

Table A2.

Pearson Correlation and p values for shoots and different variables of the benthic populations				
	Biomass	Richness	Diversity	Abundance
Pearson Correlation	0.003	0.433	0.135	0.091
p value	0.204	1.48E-0.5	1.46E-0.5	0.08
Paired t test (one tail values)for various parameters between seasons				
	Abundance	Richness	Evenness	Diversity
p value	0.11	0.08	0.11	0.09